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The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

12 a. DISTRIBUTION / AVAILABILITY STATEMENT

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13. ABSTRACT (Maximum 200 words)

A theory of training codes was developed for the multi-antenna, non-coherent, multiple block Rayleigh fading channel. The key advantage of training codes is that they are easily designed to have high rate and low decoding complexity by choosing an underlying coherent code to have high rate and to be efficiently decodable. A key performance analysis result of this work is that the training codes when decoded with the estimator-detector receiver achieve a diversity order of the error probability that is equal to the diversity order of the underlying coherent code. Several examples of training codes were provided in this work that have polynomial decoding complexity in rate but an error rate comparable to the best performing unitary designs available, even though the latter require exponential decoding complexity.

The theory developed in this project is relevant for the design of delay sensitive wireless multi-antenna communication systems in a variety of applications, particularly those encountered in rich scattering environments and high vehicular speed, high carrier frequency (or fast fading) channels.

14. SUBJECT TERMS
Antenna diversity, block-fading channels, error analysis, MIMO-OFDM, noncoherent, Rayleigh fading, signal design, space-time modulation, space--time codes, training, unitary space--time modulation, wireless communication.

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Mahesh K. Varanasi received no salary from this grant.

Students that received support in part by this ARO Grant G-DAAD19-03-1-0248:

Pranav Dayal
Shivratna Giri Srinivasan

Human resource development:

Pranav Dayal is pursuing his PhD and will most likely finish in 2005.
Shivratna Srinivasan has recently begun his doctoral research.

Detailed technical description of research performed:

A theory of training codes is developed for the multi-antenna, noncoherent, multiple block Rayleigh fading channel in which the fading coefficients, which are constant over a fixed number of dimensions (coherence interval) for each block and then change independently to a new realization, are known neither at the transmitter nor the receiver. Each codeword of a training code consists of a part known to the receiver and which is used to form a minimum mean-squared error estimate of the channel and a part that contains codeword(s) of a space--time block or trellis code designed for the coherent channel (in which the receiver has perfect knowledge of the channel). The channel estimate is used as if correct for decoding the information bearing part of the training codeword. Training codes are hence easily designed to have high rate and low decoding complexity by choosing the underlying coherent code to have high rate and to be efficiently decodable. Conditions for which the estimator-detector receiver is equivalent to the optimal noncoherent receiver were established. A key performance analysis result of this work is that the training codes when decoded with the estimator-detector receiver achieve a diversity order of the error probability that is equal to the diversity order of the underlying coherent code. In some cases, the performance of training codes can be measured relative to coherent reception via ``training efficiency,'' which is then optimized over the energy allocation between the training and data phases. In the limit of increasing block-lengths, training codes always achieve the performance of coherent reception. The examples of training codes provided in this work have polynomial complexity in rate but an error rate comparable to the best performing unitary designs available, even though the latter require exponential decoding complexity.

The results described above will be published in

M. K. Varanasi, P. Dayal and M. Brehler, “Leveraging Coherent Space-Time Codes for Noncoherent Communication via Training,” to appear, *IEEE Trans. Inform. Th.* 2004.